Department of Energy Bioenergy Technologies Office Comments on Air Force Strategic Studies Quarterly Article: ***Energy Insecurity, The False Promise of Liquid Biofuels***

General Comments

Although the author has done an extensive literature reading in the biofuels area, the paper does not have any analysis of critical issues of energy systems including petroleum systems and biofuel systems. Instead, it is a summary of literature. Furthermore, the summary of biofuel literatures in this paper has been tailored with literatures with negative points of views and results for biofuels. There are equally important, if not more important, literatures with credible analyses and objective results of biofuels, which were either overlooked or ignored by the author.

The author used energy return on investment (EROI) as a key indicator to advocate if an energy system should be invested in or not. If energy choices are made simplistically on the basis of EROI, society would eliminate electricity generation systems, since generation of electricity causes significant energy losses (for example, coal-fired electric power plants lose two-thirds of energy inputs). While the author presented the definition of EROI in a formula, he did not specify what energy types to be included in EROI calculations. Furthermore, the author did not calculate EROI himself for key energy systems that he advocated or opposed. Instead, he cited EROI values from various publications without realizing or by ignoring that scopes and system boundaries in the different studies he chose to cite could be very different. For example, the EROI values of 8:1 cited by the author for petroleum fuels do not include petroleum energy contained in gasoline or diesel. However, some of the EROI values he cited for biofuel systems appear to include renewable energy contained in biofuels. This major inconsistency in the paper caused invalid conclusions in the paper based on cited EROI values. The problem is clearly shown in Figure 1 with counterintuitive results for some of the energy systems in the figure.

The author was confused with present purchase prices of certain fuels for fleet testing versus the long term goals of government biofuel research and development (R&D) investment. The present purchase prices reflect current production at very limited scale and limited technology advancement. Government R&D investments are intended to overcome key technology barriers so that in the long term biofuels can become vital national energy options. If one uses the status quo to decide what society should or should not do, many technology innovations and civilization advancements would not have occurred.

The author did not go to the level of understanding of quantitative results and conclusions of many of the literatures cited in the paper. This misinterpretation by the author, which occurs throughout the paper, resulted in invalid conclusions. For example, he quoted the total energy use that includes the energy in the biomass for algae-based fuel systems from Frank et al. Algae may be inefficient in converting renewable energy from sunshine to liquid fuels, but the earth is not limited by the solar energy it receives. On the other hand, the earth does have a finite amount of petroleum resources. The author fails to address resource depletion issues in comparing the petroleum energy systems and biofuel systems.

The author used the term "perpetual motion machine" to characterize biofuel systems. Biofuel systems work in reality in contrast to that mischaracterization because the author failed to take into account the solar energy that is inputted into biofuel systems. That is, biofuel energy systems are designed to convert low-quality, somewhat unlimited, solar energy into liquid fuel energy.

Some of the studies cited in the paper are out of date. Many citations in the paper are from web postings, which formal journal papers would not be allowed to cite.

Specific Comments

p.115, 2nd para. Based on the congressional definition of energy security cited here, prices are not included in the definition, but the author inserted prices into his interpretation.

p.123, the biodiesel's low energy density relative to petroleum diesel is a fuel property issue, not an energy security issue. Otherwise, one might argue that hydrogen and natural gas, among many other fuels, would have severe energy security issues.

p.123, it seems that the author was confused by assuming that biodiesel would be hydrotreated to produce renewable diesel. In practice, oils from vegetation and animal fats, among other feedstocks, are hydrotreated to produce renewable diesel without going through production of biodiesel.

p.125, the last line. The statement of "corn ethanol lifecycle GHG emissions more than triple those of petroleum fuels" is with exclusion of GHG emissions of petroleum fuel combustion.

p.134-136, the section on water problems of biofuels.

The author proposed a "peak water" theory parallel to "peak oil." This is misleading because petroleum oil is extracted from an existing reserve and is not renewable; therefore, there could be a peak. Water, as we see it in rivers or ground water, is a part of the global hydrologic cycle, in which water is input as rainfall or snowmelt, consumed in a form of evapotranspiration by plants or evaporation through lakes, seas, rivers, and human activities, and then back to the atmosphere. In this hydrologic cycle, only a small fraction of water is lost when incorporated into a solid form. For example, water could be trapped with oil sands in a large retention pond of an oil field. Separation of water from the oil sands slurry in the pond is expected to take 100 years.

Water consumption and water footprint. The author appears confused between two basic concepts: water consumption and water footprint and selectively compared results from one to the other. Water consumption refers to the water consumed through a particular production activity/process or a stage in product life cycle (often to a specific water resource) while water footprint represents water consumed through a product life cycle (often for all the water resources). The two have a distinctive system boundary, methodology, and targeted resource and carry different meanings. Therefore, results from water consumption cannot be compared with results from water footprint. In an attempt to compare water consumption between various fuels, the author cited petroleum gasoline water footprint (ref. 96) and biofuel water footprint (ref. 97). It is important to point out that reference 96 is not a water footprint but a water consumption study focusing on two main stages of fuel production – fuel resource extraction/growing and fuel processing/production – for both gasoline and biofuels (from corn and cellulosic) and estimated surface and ground water consumption. Reference 97 is a water footprint study that focuses on green water (rain fall), blue water (surface and ground water), and grey water – which is a volume equivalency of the water required to dilute a certain amount of residue N fertilizer in rivers, not physically based consumption – for fuel life cycle. A comparison between the two data sets is inconsistent and meaningless. In fact, the blue water consumption comparison data required for petroleum gasoline and biofuel obtained under the same methodology is available in reference 96: conventional gasoline water consumption: 2.2-4.4 L/L ethanol BTU equivalent (US conventional), 11-160 L/L ethanol (corn), and 1.9-4.6 L/L biofuel (cellulosic). Unfortunately, the author chose not to use the data sets that derived from the same methodology for comparison.

Seawater desalination and argument. The author presented that current biofuel production cannot provide enough fuel to operate a seawater desalination plant. First, the desalination process operates on electricity as a fuel source, not ethanol. Second, current desalination plants produce fresh water for agricultural irrigation for food and human consumption, not for biofuels. Let us assume that biofuel crop is irrigated with desalinated water – which is blue water consumption or blue water use in the water footprint methodology. The water produced from the plant, 126-970 L/L ethanol equivalent of energy input, would meet the irrigation and process water requirement for biofuels produced in the U.S. Based on above section (3) (ref. 96), 11-160 L of blue water would be needed to produce a liter of ethanol - for corn ethanol produced from the regions responsible for 90% of ethanol in the U.S. After irrigation and process water consumption, there is still 115-810 L of desalinated water in excess per L ethanol produced. Therefore, in the U.S. Midwest, under the base case and current conditions, corn ethanol is able to not only provide enough fuel to power a desalination plant to produce water for irrigating the crop, but also contribute leftover fuel to power the vehicles. This is totally opposite of the conclusion drawn by the author. The key reason for the difference is that the author used the water footprint methodology results, where in addition to irrigation and process water consumption, rainfall and grey water (dilution water for chemical fertilizer residue) are included. Note that desalinated freshwater satisfies irrigation water needs, but would not displace rainfall, which contributes to a significant portion of the water footprint.